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REDUCING CALVING DIFFICULTY BY HEIFER AND SIRE SELECTION AND MANAGEMENT

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INTRODUCTION

Calf deaths caused by dystocia (calving difficulty) result in a $600 million annual loss to U.S. beef producers (Bellows and Short, 1994). Therefore, methods to reduce dystocia must be investigated, understood, and utilized to decrease the incidence and degree of calving difficulty. A review of early research was presented at the 1989 Range Beef Cow Symposium at Rapid City (Deutscher, 1989) indicating the major cause of dystocia in first calf heifers was a disproportion between the size of calf at birth (birth weight) and the cow's birth canal (pelvic area). A pelvic area/ birth weight ratio developed in Nebraska was suggested as a method to estimate the size of calf a heifer could deliver without assistance.

At the 1993 Range Beef Cow Symposium in Cheyenne, Dr. R. A. Bellows presented an extensive overview of research conducted at Miles City on numerous factors affecting calving difficulty. He concluded the following: 1) high calf birth weights were the main cause of dystocia, 2) dam pelvic area must be adequate to deliver calf, 3) selection for pelvic size will increase frame size and calf birth weight, 4) low nutrition will not reduce dystocia, 5) maternal uterine environment affects calf birth weight, 6) exercise during gestation did not affect dystocia, 7) early obstetrical assistance increased calf survival and dam subsequent pregnancy rate, and 8) hormones of calf and dam are involved in calving difficulty.

This paper will not review all the above factors but instead will try to expand on the most important and will summarize the latest research on dystocia. It will also recommend some strategies for selection and management of heifers and bulls to reduce calving difficulty.

FACTORS AFFECTING CALVING DIFFICULTY

Research has shown that many factors influence calving difficulty, but the major ones affecting young cows are calf birth weight, calf sex, heifer pelvic size, and heifer weight at calving. Interestingly, most factors are generally set at the time a heifer conceives. Therefore, producers must make management decisions prior to breeding to reduce calving difficulty.

Heifer weight

In general, heifer weight at calving has been shown to influence difficulty with the heavier heifers having less calving difficulty. Thus, many producers select the heaviest (largest) heifers for replacements. This practice may not be justified in all herds because larger heifers have larger birth weight calves and can have considerable difficulty. Also the larger, heavier heifers have a higher frame score which leads to "frame creep" and larger mature cows which cost more to maintain. Some producers are culling the top 10 percent of their heifers to reduce this problem.

A 3-year research study on factors affecting calving difficulty was recently completed at the University of Nebraska, North Platte using 550 MARC II heifers from the UNL Gudmundsen Sandhills Research Ranch. These yearling heifers were AI bred to four Angus sires (2 low and 2 high birth weight EPDs) and calved in the spring. A unique procedure was used to determine amount (degree) of calving difficulty. A pressure gauge was attached to the calf puller to measure the maximum pounds of pressure required to deliver all assisted calves. The pressure reading was then used to assign a calving difficulty score. Five calf shape measurements and the heifer pelvic area were also obtained within 24 hours of birth. This research is currently being summarized and published by Dave Colburn as part of his master degree requirements at the University of Nebraska.

Table 1 shows heifer weights at various times by calving difficulty scores. In general, heifer weights at yearling, 18 months, and precalving did not significantly affect degree of calving difficulty. In fact, the heavier heifers tended to have more difficulty in some cases. These heifers ranged in yearling weight from 600 to 750 lbs. Heifer hip height had no effect on calving difficulty. Therefore, selecting the largest yearling heifers for replacements to reduce difficulty may not be valid. It may be more beneficial to remove the top and bottom ends and keep the middle cut of heifers if they will reach puberty before breeding.

An interesting result in Table 1 is that the birth weight of the heifer (herself) was significantly higher for the difficulty scores 4 and 5. This indicates heifers that werelarge at birth had more calving difficulty as 2-year-olds because they tended to have larger birth weight calves. The heritability of birth weight is about .45 and the calf receives half of the genes from the heifer. Therefore, another method to reduce difficulty would be to select a middle cut of heifers on birth weight and not keep the top or bottom portion. This should also help produce a more uniform group of calves the next year.

Table 1. Heifer weights and hip heights by calving difficulty scores - Nebraska.

Variable	Calving difficulty score[a] 1	2	3	4	5
Pressure needed for delivery, lb	-	103	457	671	850
No. of animals	195	25	107	29	30
Heifer birth wt[b], lb	88[c]	90[cde]	90[cd]	93[de]	95[e]
Heifer wt - yearling, lb	650[c]	668[cd]	653[cd]	674[d]	664[cd]
Heifer hip ht - yearling, in	47	48	47	48	47
Heifer wt - 18 mos, lb	802[c]	834[d]	813[cd]	834[d]	821[cd]
Heifer wt - precalving, lb	957[c]	999[d]	969[cd]	991[d]	979[cd]
Heifer hip ht - precalving, in	50	50	50	50	50

(Colburn and Deutscher)
[a]Difficulty scores were: 1 = no assistance, 2 = easy pull, 3 = moderate pull, 4 = hard pull, 5 = C-section. Analyses complete with sire effects removed.
[b]Birth weight of heifer when born.
[cde](P<.05)

Heifer pelvic size and calf birth weight

Numerous research studies have shown that heifers with larger precalving pelvic areas have less dystocia. During the last 5 years, interest in pelvic measurements has increased considerably by beef producers, veterinarians, and researchers. From a survey of Nebraska veterinarians, it was estimated that over 30 percent of the replacement heifers and 50 percent of the yearling bulls were pelvic measured. They estimated a reduction of 15 percentage points in heifer dystocia during the last 5 years due to better bull and heifer selection plus management. However, some veterinarians and producers have questions on the usefulness and practical value of pelvic measurements. A review of recent research may help clarify some of the conflicting opinions.

Several studies conducted in Canada reported finding little effect of dam pelvic size on dystocia. Naazie et al. (1989) found that calf birth weight in relation to dam weight was the most important variable. Also, small pelvic dimensions tended to cause higher difficulty scores. Donkersgoed et al. (1993) assessed the repeatability (accuracy) of obtaining pelvic measurements between and within veterinarians and found they were imprecise. Their average repeatability was 40 percent which compares to 85 to 95 percent reported from studies in Missouri and Ohio. Because of the low repeatability of the Canadian measurements, the authors found little evidence to justify the use of pelvimetry to reduce dystocia. Another Canadian study by Paputungan et al. (1993) reported repeatabilities of about 50 percent. These studies illustrate the point that measurements are only useful if accurate and repeatable. The person obtaining the measurements must be knowledgeable, must follow the proper procedures and have adequate experience.

A Canadian study by Basarab et al. (1993), using a large number of heifers, found a low accuracy using the Nebraska pelvic area/calf birth weight ratios (PA/BWT) in predicting difficult births. When using Canadian ratios, they found a 79 percent accuracy and reduced dystocia by 9.5 percent. They concluded that ratios of heifer pelvic area to calf birth weight can be used to select heifers for more pelvic area per unit of body weight. This study indicates that specific ratios need to be calculated to fit each herd and management regime. The Nebraska ratios are only guidelines and need to be refined for each specific operation. In Nebraska, Colburn et al. (1993) reported the best PA/BWT ratio was 2.1 when evaluating 600 lb MARC II yearling heifers.

In Montana, Cook et al. (1993) conducted a computer simulation to evaluate effects of yearling heifer pelvic area and sire birth weight EPDs on predicting dystocia. They found that a 2.2 lb decrease in sire EPD decreased dystocia by 4 percent, while a 10 percent increase in selection pressure on pelvic area had no detectable effect. Sire selection was more effective than heifer selection on reducing dystocia. They concluded that dystocia was a result of a mismatch between calf size and cow size; and for a given pelvic area, a threshold birth weight exists above which dystocia occurs.

In our recent Nebraska study (Table 2), pelvic area only affected the heifers requiring a C-section. Those heifers had a significantly smaller pelvic area as yearlings, at pregnancy exam time and precalving. This indicates that if the small pelvic area heifers were culled before breeding, the potential C-section heifers would be reduced. Also pelvic width was slightly more important than pelvic height. Calf birth weight increased significantly with calving difficulty score and was the most important factor causing difficulty. The PA/BWT ratio decreased with the increase in difficulty and the heifers requiring C-sections had the lowest ratios. Interestingly, calf vigor after delivery decreased (increased score) with more difficult births, but the calves delivered by C-section were as vigorous as the unassisted.

Sire birth weight EPDs

Since calf birth weight is the most important factor affecting dystocia, selecting bulls to produce small to moderate birth weight calves is of primary interest. Producers want a calf to be born unassisted, with minimal stress on the cow; and a calf with the ability for rapid growth to a year of age. Sire summaries and reports are available to evaluate bulls on birth weight and growth EPDs and accuracies.

Table 2. Heifer pelvic areas and calf birth weight - Nebraska

	Calving difficulty score[a]				
Variable	1	2	3	4	5
Yearling pelvic area, cm^2	172[c]	175[c]	170[c]	174[c]	165[d]
18 mo pelvic area, cm^2	201[c]	204[c]	199[cde]	203[cd]	195[e]
Precalving pelvic area, cm^2	245[c]	247[c]	244[c]	245[c]	235[d]
Calf birth wt, lb	72[c]	76[d]	79[e]	83[f]	88[g]
Precalving PA/BWT ratio	3.4[c]	3.3[d]	3.1[e]	3.0[f]	2.7[g]
Calf vigor score[b]	2.8[c]	3.2[de]	3.1[d]	3.6[e]	2.9[cd]

(Colburn and Deutscher)
[a]Difficulty scores same as Table 1.
[b]Vigor score (1 = best, 4 = poor) of calves within 2 hrs after delivery.
[cdefg]($P<.05$)

An intensive study was conducted in Iowa by Strohbehn et al. (1993) on 490 crossbred heifers to evaluate Angus sire birth weight EPDs on dystocia and calf production (Table 3). Calf birth weight increased, as expected, with sire birth weight EPD. Overall rate of assistance was 31 percent, with the Very Low EPD sire group having 25 percent and the High group having 40 percent. The large frame heifers in this study did not tolerate the high EPD sires any easier than the smaller frame heifers. Calf weaning weights were similar among all sire groups, indicating that proper sire selection can diminish dystocia without decreasing growth rate.

Table 3. Calf birth weight and calving difficulty by sire EPD group - Iowa[a]

	Sire birth weight EPD			
Trait	Very low	Low	Average	High
Sire birth wt EPD	-1.6	1.6	3.7	6.4
Sire weaning wt EPD	24	30	28	32
Calf birth wt, lb	69	74	75	77
Calving difficulty, %	25	28	32	40

(Strohbehn et al., 1993)
[a]Four sires used within each group. Heifers assigned to groups by pelvic areas.

The North Platte study used four sires (2 low and 2 high EPDs) and found calf birth weights, in general, followed sire EPDs (Table 4). A 7-pound difference in actual calf birth weight was found compared to an 8-pound predicted difference between EPDs. Calving difficulty of heifers was lower for the low EPD sire groups (37 percent) than for the high EPD sire groups (49 percent). The percentage of heifers requiring C-sections was considerably higher for the High-1 sire group (16 percent) compared to the Low-1 sire group (3 percent). This difference cannot be explained totally by the 7-pound difference in BWT. However, calf shape analyses were standardized for birth weight, so comparisons could be made across sire groups. The High-1 sire had the larger calf head and hoof circumference (coronary band). These results indicate calves from the High-1 sire had larger bones per unit of birth weight, therefore, more difficulty during delivery. In general, research on calf shape measurements, independent of birth weight, has not found significant effects on dystocia, but these data show some influence. Producers may need to place more emphasis on size of head and bone size in selecting bulls for calving ease. The other calf measurements varied with of birth weight and showed no specific effects on dystocia.

Table 4. Calf birth weight, calf shape and calving difficulty by sire EPD[a] - Nebraska

	Sire birth weight EPD			
Trait	Low-1	Low-2	High-1	High-2
Sire birth wt EPD	-1.9	-1.8	+6.1	+5.8
Sire weaning wt EPD	+15	+30	+34	+30
No. of calves	106	93	94	93
Calf birth wt, lb	72[b]	73[b]	79[c]	80[c]
Calving difficulty, %	41[bd]	33[b]	52[c]	46[cd]
Delivery pressure, lb	246[b]	230[b]	363[c]	298[bc]
C-sections, %	3[b]	5[b]	16[c]	7[b]
Calf head circ[e], cm	45.2[b]	45.6[d]	46.0[c]	45.7[cd]
Calf hoof circ[e], cm	16.9[b]	17.0[d]	17.4[c]	17.1[d]
Calf width of shoulder[e], cm	21	21	20	21
Calf width of hips[e], cm	22	22	22	22
Calf depth of chest[e], cm	29	29	29	29
Calf weaning wt, lb	412[b]	428[c]	423[bc]	421[bc]

[a]Heifers allotted to sires by yearling weight and pelvic area. Calving difficulty percent = scores 3, 4, and 5. (Colburn and Deutscher)

[bcd](P<.05)

[e]Analyses standardized birth wt across sires.

Calf weaning weight was closely related to sire weaning weight EPD. It is noteworthy that calves from the Low-2 sire had one of the highest weaning weights and the lowest percentage calving difficulty with low birth weights. He was an unusual sire.

Environment on birth weight

Since heritability of birth weight is only about 45 percent, the remaining variation is due to environmental factors. Two factors which increase calf birth weight and calving difficulty are geographic location and the season of the year. Research has documented through AI sires that calves born in the southern states are from 6 to 10 lb lighter at birth than their northern counterparts. Also, calves born in the fall have lighter birth weights than those born in the spring. Calving 2-year-old heifers in the late spring or summer may help reduce dystocia. It is theorized that cold temperatures during late gestation cause heavier calf birth weights. Research at MARC has shown that uterine blood flow carrying nutrients to the fetus increases during cold temperatures (Ferrell, 1991). Therefore, calf birth weights may increase when cows are exposed to cold temperatures.

The 3-year study at North Platte was able to monitor temperatures and windchills over three winters prior to spring calving. Since the research protocol was standardized with similar cattle management and nutrition and the same AI sires used each year, comparison of year effects on calving data should be valid. Table 5 shows average temperatures and windchills for the mild winter of 1994-95 were 11 degrees higher than for the severe winter of 1992-93. The subsequent calf birth weights were surprisingly 11 pounds heavier in 1993 compared to 1995 (82 versus 71 pounds). Calving difficulty, as expected, decreased from 58 percent to 35 percent over the 3-year period. These results support the theory that cold temperatures increase calf birth weights. Therefore, if winter temperatures are below normal, producers may expect heavier calves in the spring and more calving difficulty.

Table 5. Winter temperatures and calf birth weights and calving difficulty - Nebraska

	Winter			
Trait	1992-93	1993-94	1994-95	Year difference[a]
Avg air temperatures (Dec, Jan, Feb), deg	20[b]	26[c]	31[c]	+11
Avg wind chill, deg	12[b]	18[b]	23[c]	+11
Calf birth wt, lb	82[b]	76[c]	71[c]	-11
Calving difficulty, %	58[b]	47[b]	35[c]	-23

(Colburn et al., 1996)
[a]Differences between first and last year.
[bc](P<.10)

Calf sex on birth weight

Male calves are heavier at birth than female calves and have more dystocia. Calf sex is determined at conception so it is out of our control. However, future technology for sexing semen and (or) embryos may allow us to produce only female calves from first-calf heifers. This practice would reduce dystocia.

Bull pelvic size

Many producers are using pelvic size as a selection criterion in bulls to increase pelvic size in daughter offspring. Pelvic area heritability estimates have ranged from .24 to .92 with an average of .51 (Table 6). If the heritability is moderate to high, then selection pressure should readily transmit the trait to the progeny.

Table 6. Summary of pelvic area heritability estimates

Research study	h^2	Research study	h^2
Neville et al. (1978)	.24	Nelson et al. (1986)	.40
Benyshek and Little (1982)	.53	Green et al. (1988)	.92
Holzer and Schlote (1984)	.36	Anderson et al. (1991)	.46
Green et al. (1984)	.61	Naazie et al. (1991)	.77
Bolze (1985)	.51	Kriese et al. (1994)	.25
Morrison et al. (1986)	.68	Kriese et al. (1994)	.24
Nelson et al. (1986)	.68	Average	.51

However, if the heritability is low (.25) as indicated by a large study conducted at MARC, Nebraska (Kriese et al., 1994), then progress will be slow. These authors also reported that the genetic correlation between male and female pelvic area was .61, indicating that the trait is not the same in both sexes. They stated that the male and female pelvic traits are largely under the same genetic control, but should be considered correlated traits rather than the same trait. The MARC data showed the genetic correlations between male and female pelvic areas for 12 different breed groups ranged from .04 to 1.0 with an average of .61. However, over half of the breed groups had a correlation of 1.0, indicating the same trait. Green et al. (1986) also reported a genetic correlation between male and female pelvic area of .60.

Kriese (1995) presented a paper to the 1995 BIF conference and discussed the effects of the correlated traits. She suggested if sires are selected on pelvic area, only a small positive genetic change would be seen in daughter yearling pelvic area. Therefore, only a small reduction in calving difficulty would be realized through selection of sires on pelvic size. More studies are needed on the effect of sire pelvic size on daughter calving ease.

Siemens et al. (1989) evaluated pelvic measurements on 1600 bulls and found the average pelvic area was 160 cm^2 for a 1000-pound yearling bull. For every 100-pound change in yearling weight, pelvic area changed about 10 cm^2. Therefore, average pelvic areas were 150, 160, 170 cm^2 for yearling bulls weighing 900, 1000, and 1100 pounds, respectively. BIF guidelines recommend that bulls be adjusted to 365 days of age to make genetic comparisons on pelvic size. The adjustment factor is .25 cm^2/day for bulls on performance tests gaining 2.5 to 4.5 lb/day. Thus, yearling bulls offered for sale should have passed fertility exams and have adjusted yearling pelvic areas reported.

RECOMMENDATIONS ON SELECTION

In a review paper from Colorado, Anderson et al. (1993) concluded that numerous factors influence dystocia, but calf birth weight was the most important factor and size of dam's pelvic area was second. Strategies recommended for minimizing dystocia were:

1. When selecting sires for mature cows to produce replacement heifers, they should have birth weight EPDs lower than average of the breed and have adjusted yearling pelvic areas average or higher.

2. When selecting replacement heifers before breeding, cull all heifers with unacceptably small pelvic measurements, both width and height. Culling the smallest 10 percent on pelvic width may be most beneficial.

3. When selecting sires to breed heifers, they should be chosen with emphasis on low birth weight EPD.

Kriese (1995) recommended two other strategies that can be effective in reducing dystocia: 1) Cull replacement females on yearling pelvic areas using the pelvic area/birth weight ratios developed by Nebraska (Deutscher, 1991); and 2) Use high accuracy, low birth weight EPD sires with acceptable growth rates on yearling heifers.

In addition to the above recommendations, our recent Nebraska data would indicate:

1. Cull the heifers that had high birth weight themselves to help reduce calf size and dystocia.

2. Consider culling the top 10 percent of heifers with the largest frame size and heaviest weight because they have larger calves at birth and more difficulty. Also, they will increase mature cow size in herds with already large size cows.

3. Observe bone structure of bulls and refrain from selecting those with large heads or heavy bone to use on heifers.

Management strategies for heifers

In addition to heifer selection, proper heifer development, a good breeding program, management of bred heifer and proper care at calving are very important.

Goals for developing heifers should include proper nutrition to allow heifers to reach puberty early, to conceive early in a short breeding season, and to have adequate skeletal structure to minimize calving problems. Heifers should reach "target weights" of about 65 percent of projected mature weight before breeding and about 85 percent before calving.

Heifers should be given a breeding soundness exam (similar to bulls) before the breeding season to help ensure early conception and reduced calving difficulty. This program involves 5 steps: make final selection on size and health, obtain pelvic measurements, palpate ovaries and reproductive tract (to determine puberty, free martins, or unexpected pregnancy), vaccinate for reproductive diseases, and ear tag for identification (if needed). All can be accomplished during one processing through the chute about 3 weeks before the breeding season.

Estrous synchronization and AI programs work well for yearling heifers by shortening the breeding season and allowing use of proven calving ease sires. Only heifers conceiving during first 30 to 45 days of breeding season should be kept for replacements. Pregnant heifers should be fed adequately, not underfed or overfed. Restricting protein or energy to heifers in moderate body condition is not recommended because it does not reduce dystocia, but does decrease calf vigor and lowers rebreeding performance of dam.

Frequent observation at calving time with proper assistance (when needed) will save many calves. A prolonged delivery causes stress on the heifer, increases probability of losing calf and lowers rebreeding performance of heifers.

SUMMARY

The major factors affecting dystocia of young cows are calf birth weight, calf sex, heifer pelvic size, and heifer weight. Strategies to minimize dystocia include: select bulls with low birth weight EPDs and acceptable growth rates to use on heifers, cull heifers with small pelvic sizes, select heifers with moderate birth weights and yearling weights, plus provide heifers with good nutrition, breeding, and calving management. Calving difficulty can be reduced through proper selection and management of heifers and bulls.

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